

APPROVAL SHEET FOR SUSPENDED LOAD OPERATIONS

SLO-KSC-1991-004

TITLE Orbiter Mate to the Shuttle Carrier Aircraft (SCA)
at Contingency Landing Site (CLS)

DOCUMENT NUMBER/TITLE OMI S5044, V9005

PREPARED BY M. Glenn

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REQUIRED APPROVAL

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**NASA SUSPENDED LOAD OPERATION
ANALYSIS/APPROVAL (SLOAA)**

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OPERATION: Orbiter Mate to the Shuttle Carrier Aircraft (SCA) at Contingency Landing Site (CLS)

SUPPORTING DOCUMENTS: The associated operational procedure/systems assurance analyses are as follows:

1. OMI S5044, Post Landing Deservicing/Mate to SCA - CLS.
2. OMI V9005VL2, Hydraulic Standard Power up/down.
3. SAA09FT01-004, Systems Assurance Analysis of the Link Belt 250-Ton Truck Crane HC-268.
4. KSCL-5312-0839, Reliability and Safety Study of the 800 Ton DEMAG TC4000 Mobile Crane at Contingency Landing Sites.

GENERAL DESCRIPTION: This operation involves the mate of the Orbiter to the SCA using the 800 ton TC4000 Demag mobile crane (leased) and 250 ton Link Belt mobile crane (owned by NASA). After mate, the Orbiter is ferried to KSC, demated from the SCA and towed to the Orbiter Processing Facility (OPF) to be readied for its next flight. A detailed engineering review and hazards analysis of this operation has been conducted. This work has resulted in hardware and/or procedure modifications that minimize the exposure of employees to working under suspended loads. Due to the uniqueness of the activity and the limitations using present systems, hardware, and facilities, there remain some tasks where suspended load operations are required under specifically approved and controlled conditions. The Orbiter mate to the SCA requires a minimum number of personnel under the load to perform the following tasks:

1. Sweep the apron area under the suspended H70-0743 Orbiter Ferry Flight lifting sling to remove foreign object debris (1 person – 5 minutes).
2. Tow/spot Orbiter and SCA into the lift apron and tow SCA/Orbiter out of the lift apron passing under the suspended H70-0743 Orbiter Ferry Flight lifting sling (3 personnel - 20 minutes).
3. Install Orbiter/SCA spotting lines using transits on the lift apron for vehicle alignments under the H70-0743 Orbiter Ferry Flight lifting sling and Orbiter (2 personnel - 30 minutes).
4. Install/remove the H70-0743 Orbiter Ferry Flight lifting sling on the Orbiter at the four Orbiter lifting attach points (2 forward, 2 aft) (2 personnel each attach point - 4 hours).
5. Remove earth ground, ground lock pins and armalon, associated with landing gear retraction and observe gear closure and assist NLG door closure (6 personnel - 90 minutes).
6. Disconnect hydraulics from the Orbiter left hand external tank umbilical associated with landing gear retraction (6 personnel - 45 minutes).

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7. Install the Orbiter left hand external tank umbilical ferry door after hydraulic disconnection (5 personnel - 30 minutes).
8. Monitor the aft Orbiter socket onto the aft SCA ball and forward bipod connection of the Orbiter/SCA in a dynamic lift until mating is achieved (4 personnel each aft attach point, 4 personnel forward attach point - 1 hour).
9. Remove forward/aft cups and liners (8 personnel – 30 minutes).

RATIONALE/ANALYSIS: The suspended load tasks comply with the NASA Alternate Safety Standard for Suspended Load Operations as follows:

Alternate Standard Requirement #1a: Orbiter/SCA mate operations at the CLS cannot be conducted without personnel beneath the suspended load. The tasks performed under the load have been analyzed and evaluated with the determination no feasible engineering design or procedural options are readily available to eliminate the suspended load operation.

Alternate Standard Requirement #1b: Secondary support systems to assume support of (catch) the load were evaluated and were not feasible for this operation. Design criteria was too cumbersome to prevent the Orbiter and sling from being a suspended load and also prevented access to areas of critical work that needed to be performed.

Alternate Standard Requirement #1c: The number of personnel allowed under the suspended load for each task is as stated in the General Description. These personnel are also identified with safety vests to annotate the required personnel for the operation.

Alternate Standard Requirement #1d: Personnel will accomplish the required suspended load tasks as quickly and safely as possible to minimize time exposure; see General Description.

Alternate Standard Requirement #2: Suspended load operations are reviewed and approved on a case-by-case/specific need basis - see General Description and Alternate Standard Requirement #1.

Alternate Standard Requirement #3: Only those suspended load operations approved by the NASA Safety and Mission Assurance Division Chief will be permitted. A list of approved suspended load operations will be maintained by the NASA Safety and Mission Assurance Division.

Alternate Standard Requirement #4: OMIs S5044 and V9005VI2 are written to allow only required personnel under the suspended load. The OMIs are available on site for inspection during the operation.

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Alternate Standard Requirement #5: A new suspended load operation not covered by this SLOAA, deemed necessary due to unusual or unforeseen circumstances where real time action is required, shall be documented and approved by the NASA Safety and Mission Assurance Division Chief.

Alternate Standard Requirement #6: The mobile cranes are designed, tested, inspected, maintained, and operated in accordance with the NASA Safety Standard for Lifting Devices and Equipment, NSS/GO-1740.9. The H70-0743 Orbiter Ferry Flight lifting sling is designed with a safety factor of 5 against ultimate strength and a safety factor of 3 against yield.

The cranes' lifting mechanisms are equipped with dual means of braking.

The live wire rope for these cranes meet a design safety factor of 3.5 based on ultimate strength (per ANSI-B30.5).

The 250 ton mobile crane is load tested annually at 100 percent of the crane's rated capacity. Detailed crane preventive maintenance is performed monthly, semi-annually and annually, including monthly wire rope inspection and annual crane hook nondestructive testing.

Two 800 ton Demag TC4000 mobile cranes have been identified for use; one located in Baton Rouge, Louisiana (Nichols) and one located in Montreal, Quebec (Guay Crane Service). Both cranes are inspected annually and before shipment (for use) to the CLS by KSC Crane Engineering personnel. Nichols or Guay Crane Service personnel will be at the CLS.

The 250 ton and 800 ton mobile cranes will be load tested, operationally tested and inspected at the CLS prior to use.

When performing the mate operation, the 250 ton crane is connected to the forward attach point of the H70-0743 Orbiter Ferry Flight lifting sling and the 800 ton crane is connected to the aft attach point. The Orbiter will not exceed 240,000 pounds (varies with Orbiter and payload configuration) and the Orbiter lifting sling weighs approximately 26,000 pounds. The lift capacity at 85 percent rating of the 800 ton mobile crane used to lift the aft load at the designated boom length of 177 feet and radius of 112 feet is 109 tons. The lift capacity at 85 percent rating of the 250 ton mobile crane used to lift the forward load at the designated boom length of 110 feet and radius of 40 feet is 190 tons. These cranes are lifting a maximum load of approximately 130 tons which is within their rated capacity.

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Alternate Standard Requirement #7: A System Assurance Analysis (SAA) has been completed on the 250 ton mobile crane. The SAA includes a Failure Modes and Effects Analysis/Critical Items List (FMEA/CIL) and a hazard analysis (see Supporting Documents). The SAA identifies no single failure points (SFP's).

A Reliability and Safety study has been performed on the 800 ton mobile crane. The study includes a FMEA/CIL and a hazard analysis (see Supporting Documents).

The study identifies two SFPs, the hydraulic motor and the pressure relief valve. The hydraulic motor transfers fluid power to the main hoist and the pressure relief valve prevents overpressurization of the hydraulic motor. Component structural failure or a blown seal in the hydraulic motor would cause the load to lower and failure of the relief valve in the open position would cause the load to lower.

There is no history of failure with the SFPs in the critical failure mode. The use of high quality, reliable components, and a comprehensive maintenance, inspection and test program (including preoperational checks) ensures that the crane systems operate properly.

Alternate Standard Requirement #8: Visual inspections for cracks or other signs of damage or anomalies are performed on the hoist hooks and lifting sling assembly along with crane functional checks prior to each operation per NSS/GO-1740.9.

Alternate Standard Requirement #9: The crane operators and mechanical technicians are all trained and have current certifications. Operators will remain at the crane controls while personnel are under the load.

Alternate Standard Requirement #10: Appropriate control areas are established and maintained prior to and during the operation. Only required personnel (man loaded in the procedure) are permitted in this area.

Alternate Standard Requirement #11: Personnel are briefed just prior to performing the task about the hazard involving the suspended load. A pretask briefing and a safety walkdown of the area are conducted prior to the lift to ensure all systems and personnel are ready to support. All participants are instructed on their specific tasks and warned of the hazards involved. Following any crew change, new personnel are instructed by the task leader on their specific tasks and warned of the hazards involved.

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Alternate Standard Requirement #12: Personnel beneath the suspended load will be in radio, visual, or voice contact with the crane controller and/or signal person. Upon loss of communication, the operation shall stop immediately, personnel shall clear the hazardous area, and the load shall be safed. Operations shall not continue until communications are restored.


Alternate Standard Requirement #13: Ground controllers and operators are properly positioned during all phases of the lifting operation in full view of the load block, lifting fixtures and fixture attach points. Personnel working beneath the load shall remain in continuous sight of the operator and/or signal person.

Alternate Standard Requirement #14: The NASA Safety and Mission Assurance Division shall conduct periodic reviews to ensure the continued safety of suspended load procedures.

Alternate Standard Requirement #15: The NASA Safety and Mission Assurance Division will provide copies of approved SLOAAs, a list of approved suspended load operations, a list of cranes/hoists used for suspended load operations and copies of the associated FMEA/CIL and hazards analyses to NASA Headquarters.

APPROVAL:

DATE:

FOR  8/8/01
William C. Higgins
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Kennedy Space Center